FAUNAL, FLORAL, WETLAND AND AQUATIC ECOLOGICAL ASSESSMENT AS PART OF THE ENVIRONMENTAL ASSESSMENT AND AUTHORISATION PROCESS FOR THE JEANETTE MINE PROJECT AT THE TAUNG GOLD MINE NEAR WELKOM, FREE STATE PROVINCE

Prepared for

SLR Consulting (Africa) (Pty) Ltd

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SECTION B – Floral Assessment

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1 INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a full ecological investigation, including a terrestrial fauna and flora assessment as well as a wetland assessment for the proposed Jeanette Gold Mine refurbishment project at the Jeanette Shaft Complex near Welkom within the Free State province, hereafter referred to as the "study area" (Section A: Figure 1 & 2). The study area is situated immediately to the east of the town of Allanridge, with the town of Odendaalsrus located 4km to the south of the study area, and Kutlwanong, located directly southeast of the study area. The R30 roadway traverses the northern section of the study area and the R34 roadway is situated to the south of the study area.

2 GENERAL SITE SURVEY

A two day field assessment was undertaken during May 2015, in order to determine the ecological status of the study area. A reconnaissance 'walkabout' was initially undertaken to determine the general habitat types found throughout the study area and, following this, specific study sites were selected that were considered to be representative of the habitats found within the area, with special emphasis being placed on areas that may potentially support Red Data Listed (RDL) species and/ or other floral Species of Conservation Concern (SCC). Sites were investigated on foot in order to identify the occurrence of the dominant plant species and habitat diversities.

3 FLORAL ASSESSMENT METHODOLOGY

3.1 Vegetation Surveys

Vegetation surveys were undertaken by first identifying different habitat units and then analysing the floral species composition that were recorded during detailed floral assessments using the step point vegetation assessment methodology. Different transect lines were chosen within areas that were perceived to best represent the various plant communities. Floral species were recorded and a species list was compiled for each habitat unit. These species lists were also compared with the vegetation expected to be found within the relevant vegetation types as described in Section 4, which serves to provide an accurate

indication of the ecological integrity and conservation value of each habitat unit (Evans & Love, 1957; Owensby, 1973).

3.2 Vegetation Index Score

The Vegetation Index Score (VIS) was designed to determine the ecological state of each habitat unit defined within an assessment site. This enables an accurate and consistent description of the PES concerning the study area in question. The information gathered during the assessment also contributes towards the sensitivity mapping, leading to a more truthful representation of ecological value and sensitive habitats.

Each defined habitat unit is assessed using separate data sheets (Appendix B) and all the information gathered then contributes to the final VIS score. The VIS is derived using the following formulas:

VIS = [(EVC) + (SI x PVC) + (RIS)]

Where:

1. **EVC** is extent of vegetation cover;
2. **SI** is structural intactness;
3. **PVC** is percentage cover of indigenous species and
4. **RIS** is recruitment of indigenous species.

Each of these contributing factors is individually calculated as discussed below. All scores and tables indicated in blue are used in the final score calculation for each contributing factor.

1. EVC=[(EVC1+EVC2)/2]

EVC 1 - Percentage natural vegetation cover						
Vegetation cover %	**0%**	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Site score						
EVC 1 score	0	1	2	3	4	5

EVC 2 – Total site disturbance						
Disturbance score	**0**	**Very low**	**Low**	**Moderate**	**High**	**Very high**
Site score						
EVC 2 score	5	4	3	2	1	0

2. ***SI=(SI1+SI2+SI3+SI4)/4)***

	Trees (S1)		Shrubs (S2)		Forbs (S3)		Grasses (S4)	
Score	*Present state	**Perceived reference state	Present state	Perceived reference state	Present state	Perceived reference state	Present state	Perceived reference state
Continuous								
Clumped								
Scattered								
Sparse								

*Present State (P/S) = currently applicable for each habitat unit
*Perceived Reference State (PRS) = if in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived reference state (PRS)	**Continuous**	**Clumped**	**Scattered**	**Sparse**
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. ***PVC=[(EVC)-(exotic x 0.7) + (bare ground x 0.3)]***

Percentage vegetation cover (exotic)						
	0%	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Vegetation cover %						
PVC score	0	1	2	3	4	5
Percentage vegetation cover (bare ground)						
	0%	**1-5%**	**6-25%**	**26-50%**	**51-75%**	**76-100%**
Vegetation cover %						
PVC score	0	1	2	3	4	5

4. RIS

Extent of indigenous species recruitment	0	Very low	Low	Moderate	High	Very high
RIS						
RIS Score	0	1	2	3	4	5

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score	Assessment Class	Description
22 to 25	**A**	Unmodified, natural
18 to 22	**B**	Largely natural with few modifications
14 to 18	**C**	Moderately modified
10 to 14	**D**	Largely modified
5 to 10	**E**	The loss of natural habitat extensive
<5	**F**	Modified completely

3.3 Floral SCC Assessment

Prior to the field visit, a record of RDL floral species and or other Species of Conservation Concern (SCC) and their habitat requirements was acquired from the Free State Nature Conservation Bill (FSNCB; 2007), the National Environmental Management: Biodiversity Act (Act 10 of 2004) (NEMBA) and the South African National Biodiversity Institute (SANBI) for the Quarter Degree Squares (QDS) 2726DC, 2726DD and 2726DA (Appendix A). Throughout the floral assessment, special attention was paid to the identification of any of these RDL and other SCC as well as identification of suitable habitat that could potentially sustain these species.

The Probability of Occurrence (POC) for each floral species of concern (within the QDS 2726DC, 2726DD and 2726DA) was determined using the following calculations wherein the habitat requirements and habitat disturbance were considered. The accuracy of the calculation is based on the available knowledge about the species in question, with many of the species lacking in-depth habitat research. Therefore, it is important that the literature available is also considered during the calculation. Each factor contributes an equal value to the calculation.

Literature availability						
Criteria	**No literature available**					**Literature available**
Score						
	0	1	2	3	4	5
Habitat availability						
Criteria	**No habitat available**					**Habitat available**
Score						
	0	1	2	3	4	5
Habitat disturbance						
Criteria	**Pristine**	**Very low**	**Low**	**Moderate**	**High**	**Very high**
Score						
	5	4	3	2	1	0

[Literature availability + Habitat availability + Habitat disturbance] /15 x 100 = POC %

4 FLORAL DESCRIPTION

4.1 Biome and Bioregion

Biomes are broad ecological units that represent major life zones extending over large natural areas (Rutherford, 1997). The study area falls within the Grassland and the Azonal Vegetation biome (Rutherford and Westfall, 1994) (Figure 1). Biomes are further divided into bioregions, which are spatial terrestrial units possessing similar biotic and physical features, and processes at a regional scale. The study area is situated within the Dry Highveld Grassland, the Alluvial Vegetation and the Inland Saline Vegetation Bioregion (Mucina and Rutherford, 2010 (Figure 2).

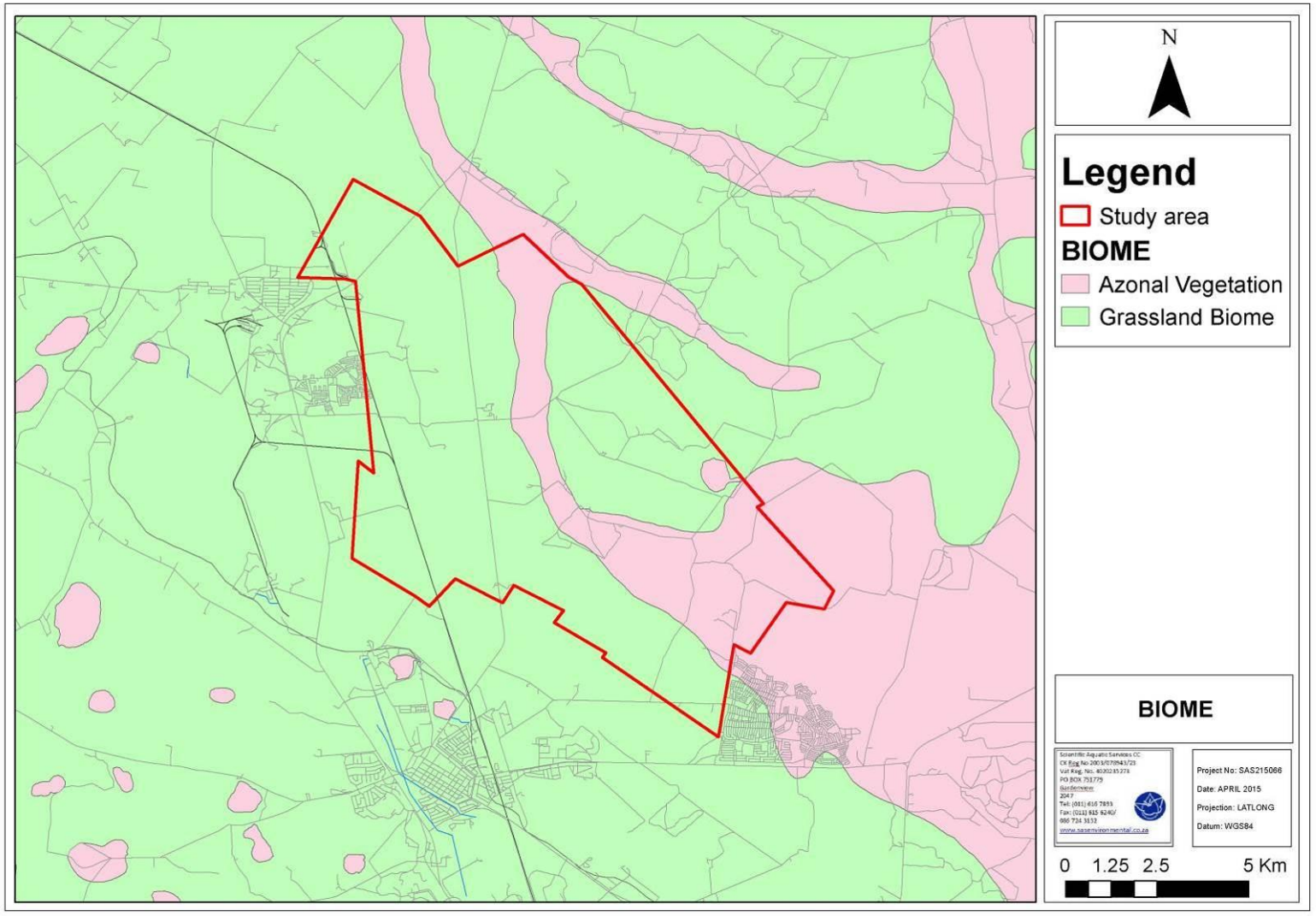

Figure 1: Biome associated with the study area (Mucina and Rutherford, 2010).

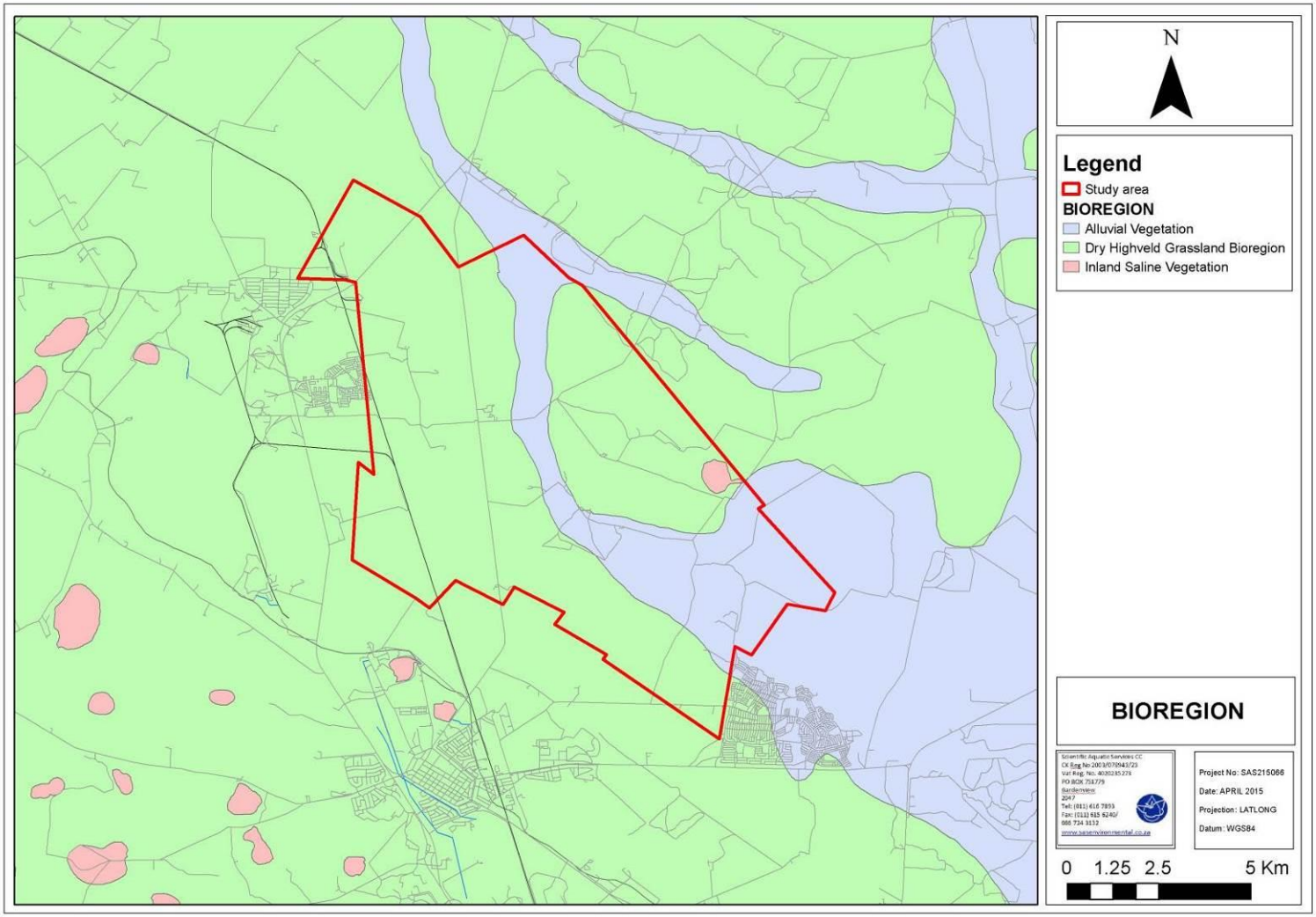

Figure 2: Bioregion associated with the study area (Mucina and Rutherford, 2010).

4.2 Vegetation Type and Landscape Characteristics

While biomes and bioregions are valuable as they describe broad ecological patterns, they provide limited information on the actual species that are expected to be found in an area. Knowing which vegetation type an area belongs to provides an indication of the floral composition that would be found if the assessment site was in a pristine condition, which can then be compared to the observed floral list and so give an accurate and timely description of the ecological integrity of the assessment site. When the boundary of the assessment site is superimposed on the vegetation types of the surrounding area (Figure 3), it is evident that the study area falls within the Highveld Alluvial Vegetation, Vaal Vet Sandy Grassland and the Highveld Salt Pans vegetation types (Mucina and Rutherford, 2010). The characteristics of these vegetation types are discussed below.

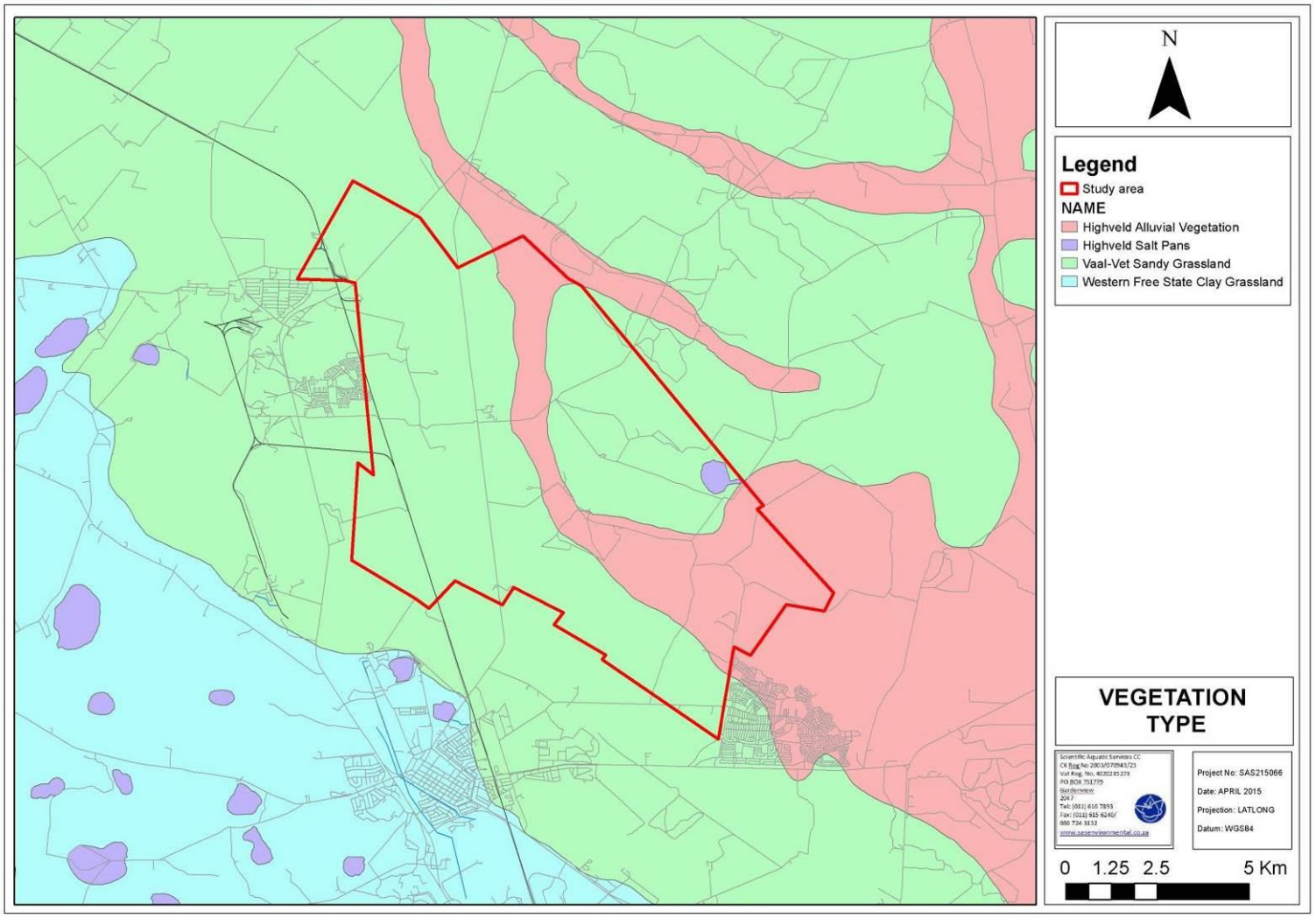

Figure 3: Vegetation types associated with the study area (Mucina and Rutherford, 2010).

4.3 Vaal-Vet Sandy Grassland

4.3.1 Distribution

The *Vaal-Vet Sandy Grassland* occur within the North West and Free State Provinces, south of Lichtenburg and Ventersdorp, stretching southwards to Klerksdorp, Leeudoringstad, Bothaville and to the Brandfort area north of Bloemfontein. The altitude varies between 1220m and1560m, with an average altitude of 1260-1360m (Mucina and Rutherford, 2010).

4.3.2 Climate

Vaal-Vet Sandy Grassland is characterised by warm temperate, summer rainfall, with an overall Mean Annual Precipitation (MAP) of 530mm. The region experiences high summer temperatures, and in winter undergoes severe frost (on average 37 days per annum) (Mucina and Rutherford, 2010).

4.3.3 Geology and soils

The *Vaal-Vet Sandy Grassland* is characterised by Aeolian and colluvial sand overlaying sandstone, mudstone and shale of the Karoo Supergroup (mostly the Ecca Group) as well as the older Ventersdorp Supergroup andesite and basement gneiss in the north. These soils form part of Avalon, Westleigh and Clovelly. The dominant land type of this region is Bd, which is closely followed by Bc, Ae and Ba (Mucina and Rutherford, 2010).

4.3.4 Conservation

Vaal-Vet Sandy Grassland is considered Endangered (Target 24%). Only a very small fraction (0.3%) is statutorily conserved in the Bloemhof Dam, Schoonspruit, Sandveld, Faan Meintjies, Wolwespruit and Soetdoring Nature Reserves. More than 60% of the area is transformed primarily for cultivation of commercial crops, whereas the remaining 40% is under strong grazing pressure from cattle and sheep. Erosion is very low (85.3%) and low (11%) (Mucina and Rutherford, 2010).

4.3.5 Dominant Floral Taxa

The vegetation within the *Vaal-Vet Sandy Grassland* occurs in plains-dominated landscapes with some scattered, slightly irregular undulating plains and hills. Many low-tussock grasslands with an abundant karroid element are present within this area. An important

feature of the vegetation type is the dominance of *Themeda triandra*. In areas where heavy grazing and/or erratic rainfall occurs low cover of *T. triandra* associated with an increase in *Elionurus muticus, Cymbopogon pospischii* and *Aristida congesta* is evident.

The table below presents the key indicator species of this vegetation type:

Table 1: Key indicator floral species associated with the Vaal-Vet Sandy Grassland vegetation type (Mucina and Rutherford, 2010).

Grass species	Forb species	Tree/Shrub species
Anthephora pubescens (d)	*Berkheya onopordifolia* var.	*Felicia muricata (d)*
Aristida congesta (d)	*onopordifolia*	*Anthospermum rigidum* subsp.
Chloris virgata (d)	*Chamaesyce inaequilatera*	*pumilum*
Eragrostis chloromelas (d)	*Stachys spathulata*	*Helichrysum dregeanum*
E trichophora (d)	*Barleria macrostegia*	*H. paronychioides*
E. lehmanniana (d)	*Geigerua aspera* var. *aspera*	*Pentzia globosa (d)*
E. plana (d)	*Helichrysum caespititium*	*Ziziphus zeyheriana*
Panicum gilvum (d)	*Hermannia depressa*	
Setaria sphacelata (d)	*Hibiscus pusillus*	
Themeda triandra (d)	*Monsonia burkeana*	
Tragus berteronianus (d)	*Rhynchosia adenodes*	
Cymbopogon caesius (d)	*Selago densiflora*	
Cynodon dactylon (d)	*Vernonia oligocephala*	
Digitaria argyrograpta (d)	Geophytic Herbs	
Heteropogon contortus (d)	*Bulbine narcissifolia*	
Brachiaria serrata	*Ledebouria marginata*	
Cymbopogon pospichilii	Succulent Herbs	
Eragrostis curvula	*Tripteris aghillana var. integrifolia*	
E. obtusa		
E. superba		
Digitaria eriantha		
Pancium coloratum		
Pogonarthria squarrosa		
Trichoneura grandiglumis		
Triraphis andropogonoides		

**d= dominant species*

4.4 Highveld Alluvial Vegetation

4.4.1 Distribution

Highveld Alluvial Vegetation is distributed in Free State, North west, Mpumalanga and Gauteng Provinces, as well as in Lesotho and Swaziland where it occurs along alluvial drainage lines and floodplains along rivers embedded within the Grassland Biome and marginal (eastern) units of the Kalahari (Savanna Biome) such as along Upper Riet, Hartz, Upper Modder, Upper Caledon, Vet, Sand, Vals, Wilge, Mooi, Middle and Upper Vaal Rivers, etc. and their numerous tributaries. It occurs at an altitude range of 1,000-1,500m within a flat topography supporting riparian thickets, which are mostly dominated by *Vachellia karroo*, accompanied by seasonally flooded grassland and disturbed herb lands that are often dominated by alien plants.

4.4.2 Geology and Soils

The geology typical of *Highveld Alluvial Vegetation* is characterised by deep sand to clayey (but mostly coarse sand) alluvial soils developed over Quaternary alluvial (fluviatile) sediments. Oakleaf, Dundee, Shortlands, Glenrosa and Mispah soil forms were identified in the Vaal River floodplain. The rivers are perennial, often in flood in summer. Erosion of banks, deposition of new fine soil on alluvium can be of considerable extent. Some smaller anastomosing channels of major rivers can dry out in winter (Mucina & Rutherford, 2006).

4.4.3 Climate

Highveld Alluvial Vegetation also falls in a seasonal, mainly summer rainfall region. Precipitation in the western part of the Highveld is erratic (MAP 300-400mm) increasing sharply towards the eastern north (up to 600mm in places). The overall MAP is almost 500mm (373mm at the western distribution limit and 593mm at the northern distribution limit). The area has a typical continental thermal regime, showing subtropical features is typical of the summer season (daily temperature often surpassing 35°C), while cold temperate features (such as frequent frost) prevail in winter (Mucina & Rutherford, 2006).

4.4.4 Conservation

Highveld Alluvial Vegetation is classified as *Least Threatened*, with a conservation target of 31%. Only nearly 10% of the vegetation type is statutorily conserved in Barberspan (a Ramsar site), Faan Meintjie, Sandveld, Schoonspruit, Soetdoring and Wolwespruit Nature Reserves. More than a quarter has been transformed for cultivation and by building of dams (Bloemhof, Erfenis, Krugersdrif, Mockes and Vaalharts Dams). The Highveld alluvia are prone to invasion by a number of weeds, obviously encouraged by the high nutrient status of the soils and ample water supply. Woody plants such as *Salix babylonica, Schinus molle, Melia azedarach, Celtis sinensis, Morus alba, Populus x canescens, Nicotiana glauca* and *Nicotiana longiflora* and forbs such as *Argemone ochroleuca, Chenopodium strictum, Conyza canadensis, Datura stramonium, Melilotus alba, Oenothera indecora, Paspalum dilitatum, Paspalum urvillei, Pennisetum clandestinum, Tagetes minuta, Verbena bonariensis, Xanthium strumarium* and *Zinnia peruviana* often dominate either the riverine thickets or grasslands or form ruderal communities in disturbed habitats. The undergrowth of the alluvial riparian thickets and the accompanying grasslands suffer from heavy overgrazing in many places (Mucina & Rutherford, 2006).

4.4.5 Dominant Floral Taxa

The vegetation within the *Highveld Alluvial Vegetation* is characterised by flat topography supporting riparian thickets mostly dominated by *Vechellia karroo,* accompanied by seasonally flooded grassland and disturbed herblands often dominated by alien plants.

The table below presents the key indicator species of this vegetation type:

Table 2: Key indicator floral species associated with the Highveld Alluvial Vegetation type (Mucina and Rutherford, 2010).

Grass species	Forb species	Tree/Shrub species
Riparian thickets		
Setaria verticillata (d) *Panicum maximum*	*Pollichia campestris*	**Small trees:** • *Vachellia karroo (d)* • *Salix mucronata subsp. mucronata (d)* • *S. mucronata subsp. woodii (d)* • *Ziziphus mucronata (d)* • *Celtis africana* • *Rhus lancea* **Tall shrubs:** • *Gymnosporia buxifolia (d)* • *Rhus pyroides (d)* • *Diospyros lycioides* • *Ehretia rigida* • *Grewia flava* **Low shrubs:** • *Asparagus laricinus (d)* • *A. suaveolens (d)* **Woody climber:** • *Clematis brachiata* **Succulent shrub:** • *Lycium hirsutum (d)*
Reed beds		
Megagraminoid: • *Phragmites australis* (d)		
Flooded grasslands & herblands		
Agrostis lachnantha (d) *Andropogon eucomus (d)* *Chloris virgata (d)* *Cynodon dactylon (d)* *Eragrostis plana (d)* *Hemarthria altissima (d)* *Imperata cylindrical (d)* *Ischaemum fasciculatum (d)* *Miscanthus junceus (d)* *Paspalum distichum (d)* *Andropogon appendiculatus* *Brachiaria marlothii* *Cyperus denudatus* *C. longus* *Echinochloa holubii* *Eragrostis obtuse* *E, porosa*	*Persicaria lapathifolia* (d) Alternanthera sessilis Barleria acrostegia Corchorus asplenifolius *Equisetum ramosissimum* *Galium capense* *Hibiscus pusillus* *Lobelia angolensis* *Nidorella resedifolia* *Persicaria amphibia* *P. hystricula* *Pseudognaphalium oligandrum* *Pulicaria scabra* *Rorippa fluviatilis var. fluviatilis* *Senecio inornatus* *Stachys hyssopoides* *Vahlia capensis*	**Low shrubs:** • *Gomphocarpus fruticosus (d)* • *Felicia muricata* **Succulent shrub:** • *Salsola rabieana*

Grass species	Forb species	Tree/Shrub species
Fimbristylis ferruginea *Panicum coloratum* *Pycreus mundii* *Sporobolus africanus* *S, fimbriatus* *Themeda triandra* *Urochloa panicoides*	**Geophytic Herbs:** • *Crinum bulbispermum* • *Haplocarpa lyrata*	
Open water		
	Aquatic Herb: • *Myriophyllum spicatum*	

**d= dominant species*

4.5 Highveld Salt Pans

4.5.1 Distribution

Highveld Salt Pans is distributed in the Northern Cape, Eastern Cape, North West, Free State and Gauteng Provinces: Pans scattered on broad Grassland/Karoo and Grassland/Savanna interface roughly between Mafikeng/Koster in the north and Britstown/Middelburg in the south. The highest concentrations of pans, also known as playas, are found around Dealesville, Bultfontein, Wesselsbron, Delareyville and Petrusburg. The average size of the playas in the western Free State is 0.2km^2, with a number of the largest ones (e.g. Florisbad Pan and Annaspan) measuring several kilometres across. Altitude ranges from 1 000-1 600m (Mucina & Rutherford, 2006).

4.5.2 Geology and Soils

The bottoms of the pans are usually formed by shales of the Ecca Group giving rise to vertic clays. The environment of the pans undergoes dramatic changes from freshwater systems during the wet season to saline systems as the dry season progresses and evaporation intensifies. Wind erosion is of particular significance during the dry season, when the playa basin is dry and marginal vegetation is short and sparse. Dense dust can reach several thousand metres into the air under such windy conditions (Mucina & Rutherford, 2006).

4.5.3 Climate

These salts pans within the *Highveld Salt Pans* occur in arid and semi-arid elevated regions of the Highveld, receiving less than 500 mm rain per year. Overall MAP 400 mm (range from 275 mm in the Upper Karoo to 654 mm in Gauteng). Characterised by thunderstorms leading to high water run-off and low soil absorption. The climate pattern spans bimodal

(equinoctial) to typically summer-rainfall in the northeastern regions. Frequent incidence if frost corresponds to high thermic continentality (Mucina & Rutherford, 2006).

4.5.4 Conservation

Highveld Salt Pans has a conservation target of 24%. Only a very small portion is statutorily conserved in the Vaalbos National Park and in the Bloemhof Dam, Soetdoring, Willem Pretorius, Barberspan (a Ramsar site) and S.A. Lombard Nature Reserves. About 4% has been transformed so far, but threats by agriculture, road building, mining and urbanisation are still increasing. Alien plants such as *Atriplex semibaccata, Conyza albida, Flaveria bidentis, Salsola kali, Schkuhria pinnata, Sonchus oleraceus, Spergularia rubra, Tagetes minuta, Verbena brasiliensis and Xanthium* species have been recorded in the vegetation of these salt pans (Mucina & Rutherford, 2006).

4.5.5 Dominant Floral Taxa

The vegetation within the *Highveld Salt Pans* is characterised by depressions in plateau landscape containing temporary (and less frequently also permanent) water bodies. Central parts of the pans often seasonally inundated and sometimes with floating macrophyte vegetation or the vegetation cover develops on drained bottoms of the pans and forms typical concentric zonation patterns. On the pan edges open to sparse grassy dwarf shrubland may develop, especially when the pan is under heavy grazing pressure (Mucina & Rutherford, 2006).

The table below presents the key indicator species of this vegetation type:

Table 3: Key indicator floral species associated with the Highveld Salt Pans vegetation type (Mucina and Rutherford, 2010).

Grass species	Forb species	Tree/Shrub species
Megagraminoids: • *Cyperus congestus* • *Phragmites australis* • *Typha latifolia* **Graminoids:** • *Chloris virgata (d)* • *Cynodon dactylon (d)* • *C. transvaalensis (d)* • *Cyperus laevigatus (d)* • *C. marginatus (d)* • *Diplachna fusca (d)* • *Eragrostis bicolor (d)* • *E. chloromelas (d)* • *E. plana (d)* • *Hemarthria altissima (d)*	• *Alternanthera sessilis* • *Amaranthus praetermissus* • *Aponogeton rehmannii* • *Atriplex suberecta* • *Chenopodium mucronatum* • *Gnaphalium declinatum* • *Mollugo cerviana* • *Phyla nodiflora* • *Platycarpha parvifolia* • *Pterodiscus speciosus* • *Senecio reptans* **Succulent Herb:** • *Zygophyllum simplex*	**Low shrubs:** • *Atriplex vestita* • *Felicia filifolia* • *F. muricata* • *Nenax microphylla* • *Nestlera conferta* • *Pentzia globose* • *P. incana* **Succulent shrubs:** • *Salsola glabrescens (d)* • *Lycium cinereum* • *Malephora herrei* • *Suada fruticosa* • *Titanopsis hugoschlechteri*

Grass species	Forb species	Tree/Shrub species
• *Juncus rigidus (d)* • *Panicum coloratum (d)* • *P. laevifolium (d)* • *P. schinzii (d)* • *Setaria incrassate (d)* • *Andropogon eucomus* • *Aristida adscensionis* • *Brachiaria marlothii* • *Cyperus longus* • *C. rigidifolius* • *Echinochloa holubii* • *Eleocharis palustris* • *Enneapogon desvauxii* • *Eragrostis curvula* • *E. micrantha* • *E. obtuse* • *E. stapfii* • *Fuirena coerulescens* • *F. pubescens* • *Juncus exsertus* • *Scirpoides dioecus* • *Sporobolus albicans* • *S. fimbriatus* • *S. ioclados* • *S. tenelus* • *Tragus berteronianus* • *T. racemosus*		

**d= dominant species*

5 RESULTS OF FLORAL INVESTIGATION

The majority of the study area has undergone vegetation transformation as a result of current and historic gold mining and agricultural activities. Large areas of secondary grassland are also present as a result of edge effects associated with these activities, such as woody encroachment and alteration of fire frequency and intensity. Finally, numerous ephemeral pans and a large valley bottom wetland system is present in the study area. Thus, three habitat units are present in the study area, namely the Transformed Habitat Unit, the secondary grassland Habitat Unit and the Wetland Habitat Unit. These habitat units are discussed in more detail below.

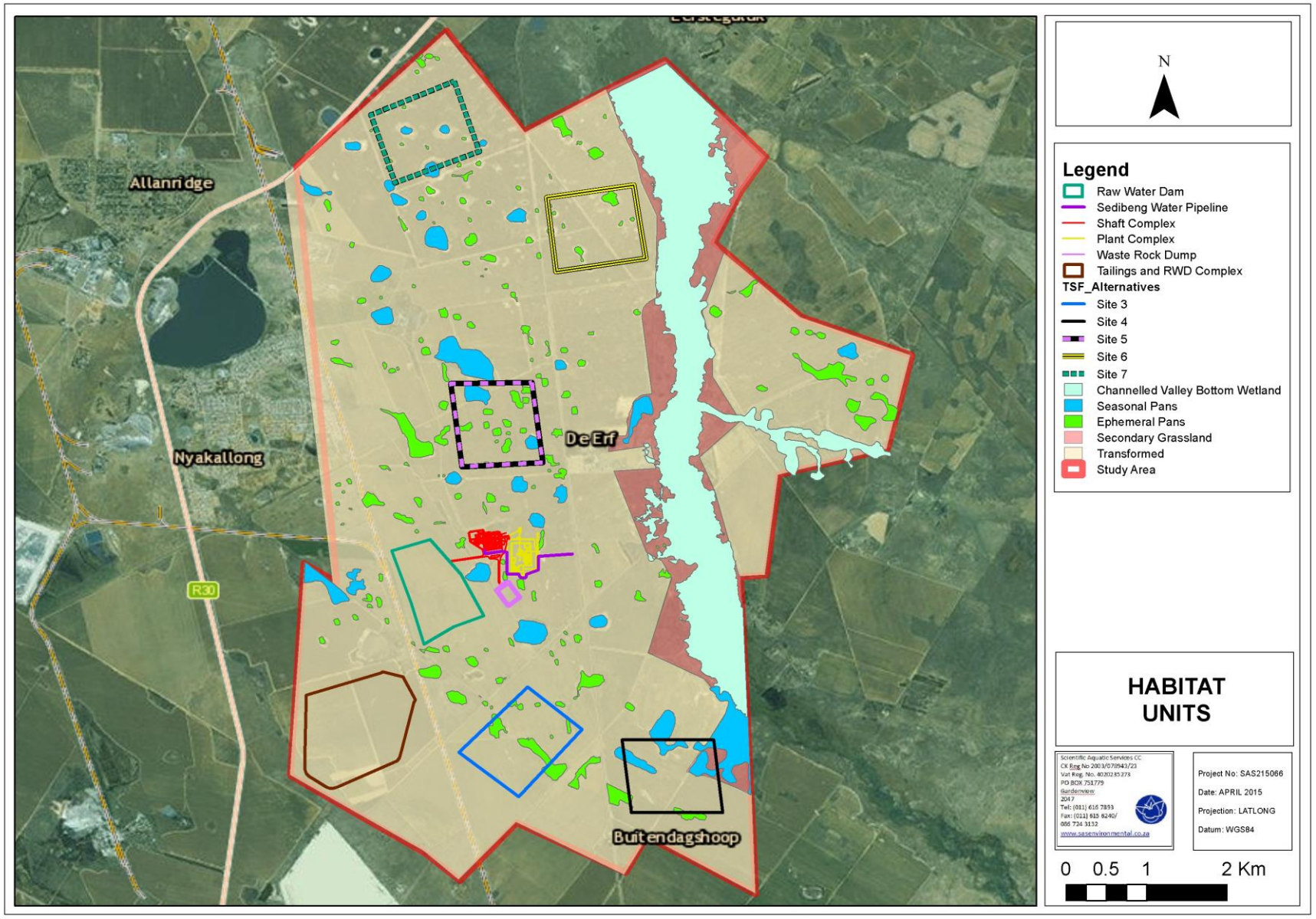

Figure 4: Habitat units identified within the study area.

5.1 Habitat Unit 1: Transformed Habitat Unit

The majority of the study area has been transformed by current and historic agricultural activities. The most severe activity associated with the transformed habitat unit is the establishment of maize fields throughout the majority of the study area. Ecological functioning was found to be extremely low in most areas. Dominant grass species other than *Zea mays* include *Cymbopogon excavatus, Pogonarthria squarrosa, Melinis repens, Hyparrhenia hirta* and *Cynodon dactylon*. These species are associated with transformation and usually grow in disturbed places such as old cultivated lands and along roadsides. Alien tree species such as *Acacia mearnsii* and *Tamarix chinensis* were also prevalent.

Figure 5: Representative photograph of the transformed habitat unit.

The ecological functionality and habitat integrity of the Transformed Habitat Unit is regarded as being very low. The abundance of alien plant species and severe vegetation transformation have resulted in this habitat unit having a very low ecological sensitivity, and little conservation value from a floral biodiversity perspective. However, edge effects from any activities occurring in this habitat unit must be effectively mitigated in order to prevent any additional negative impacts on the adjacent Wetland and Secondary Grassland Habitat Units. In the unlikely event that any SCC or protected floral species are encountered in this habitat unit, they should be rescued and relocated to surrounding natural areas.

Table 4: Dominant species encountered in the transformed habitat unit. Alien species are indicated with an asterisk.

Grass/sedge/reed species	Forb species	Tree/Shrub Species
**Zea mays*	**Bidens pilosa*	**Melia azederach*
Aristida bipartata	**Conyza bonariensis*	**Acacia mearnsii*
Aristida congesta subsp. *barbicollis*	**Tagetes minuta*	**Solanum mauritianum*
Aristida congesta subsp. *congesta*	**Verbena bonariensis*	*Seriphium plumosum*
Cynodon dactylon	**Verbena tenuisecta*	**Schinus molle*
Eragrostis chloromelas	*Acalypha angustata*	**Tamarix chinensis*
Eragrostis curvula	*Berkheya radula*	*Asparagus laricinus*
Eragrostis gummiflua	*Helichrysum kraussii*	*Acacia karroo*
Heteropogon contortus	*Ledebouria cooperii*	*Searsia lancea*
Hyparrhenia hirta	*Ledebouria ovatifolia*	**Morus alba*
Melinis repens	**Sonchus oleraceus*	**Populus x canescens*
Pogonarthria squarrosa		

5.2 Habitat Unit 2: Secondary Grassland Habitat Unit

The Secondary Grassland Habitat Unit comprises of areas where historical cropfields, overgrazing and trampling by livestock and general edge effects from agricultural activities, have transformed the graminoid layer to such an extent that it is considered to be in a secondary state of ecological succession. Additional vegetation transformation has also taken place due to the establishment of alien and invasive floral communities.

Figure 6: Representative photograph of the secondary grassland habitat unit.

Secondary grassland areas have also been affected by woody encroachment by indigenous species such as *Vachellia karroo, Asparagus laricinus* and *Seriphium plumosum*. This has led to the alteration of the floral community structure and the establishment of a sub-climax grass community. Ecological functioning, although not completely absent, was found to be low in most areas. Dominant grass species included *Eragrostis curvula* and *E. chloromelas*. These species are associated with transformation and usually grow in disturbed places such as old cultivated lands and along roadsides.

The likelihood of floral SCC occurring within this habitat unit is considered to be low, and none were encountered. Furthermore, the ecological functionality and habitat integrity of the secondary grassland habitat unit is regarded as being moderate to low, and development within this habitat unit is supported. However, edge effects from any activities occurring in this habitat unit must be effectively mitigated in order to prevent adverse impacts on the surrounding Wetland Habitat Unit.

Table 5: Dominant species encountered in the Secondary Grassland Habitat Unit. Alien species are indicated with an asterisk.

Grass/sedge/reed species	Forb species	Tree/Shrub Species
Aristida bipartata	**Bidens formosa*	**Acacia mearnsii*
Aristida congesta subsp. *barbicollis*	**Bidens pilosa*	**Melia azederach*
Aristida congesta subsp. *congesta*	**Plantago lanceolata*	**Schinus molle*
Chloris virgata	**Tagetes minuta*	**Solanum mauritianum*
Cynodon dactylon	**Taraxacum officinale*	**Tamarix chinensis*
Eragrostis chloromelas	*Acalypha angustata*	*Vachellia karroo*
Eragrostis curvula	*Berkheya radula*	*Asparagus laricinus*
Eragrostis plana	*Bulbine narcissifolia*	*Searsia lancea*
Hyparrhenia hirta	*Helichrysum kraussii*	*Seriphium plumosum*
Imperata cylindrica	*Hypoxis rigidula*	
Pogonarthria squarrosa	*Ledebouria cooperii*	
Themeda triandra	*Ledebouria ovatifolia*	
	Monopsis decipiens	
	Pelargonium luridum	
	Senecio coronatus	

5.3 Habitat Unit 3: Wetland Habitat Unit

One large valley bottom wetland system traverses the centre of the study area in a north-westerly direction. Several ephemeral pan features, that were mostly dry at the time of assessment, are also scattered throughout the study area. Various anthropogenic activities such as sewage discharge (into the valley bottom wetland), commercial crop production and intensive cattle grazing have resulted in a decrease in the ecological integrity of this habitat unit. However, the vegetation associated with the habitat is still intact and the wetlands still play an important role in providing ecosystem services and niche habitat for various faunal and floral species

Dominant floral species within the Wetland Habitat Unit include *Sporobolus africanus, Themeda triandra, Helichrysum kraussii, Setaria sphacelata* var. *torta, Imperata cylindrica, Eragrostis plana, Typha capensis* and *Persicaria lapathifolia.* These species are all indigenous and were useful in accurately delineating the wetland boundary.

In terms of RDL and floral SCC, three such species were encountered within this habitat unit, namely *Ammocharis coranica, Stapelia hirsuta* and *Crinum bulbispermum*, which were all encountered on the boundary of the valley bottom wetland system. These species are protected under the draft version of the Free State Nature Conservation Bill (FSNCB;2007), and if any individuals of these two species are to be disturbed, permits must be obtained from the Free State Department of Economic Development, Tourism and Environmental Affairs (FSDEDTEA).

As floral community structure and habitat characteristics are still largely intact, the probability of the wetland features supporting habitat for viable populations of diverse floral communities is high. Therefore, the wetlands are considered to be of high sensitivity, and disturbance of the wetlands must be avoided.

Figure 7: Representative photographs of the ephemeral pan (left) and valley bottom wetland (right) within the study area.

The table below outlines the dominant floral species encountered within the wetland habitat unit.

Table 6: Dominant species encountered in the wetland habitat unit. Alien species are indicated with an asterisk and SCC are presented in bold.

Terrestrial species	Seasonal species	Temporary species	Permanent species
Eragrostis curvula	*Berkheya radula*	*Sporobolus africanus*	*Cyperus esculentis*
Eragrostis chloromelas	***Crinum bulbispermum***	*Themeda triandra*	*Cyperus rotundus*
Cynodon dactylon	*Cynodon dactylon*	*Miscanthus junceus*	*Persicaria lapathifolia*
Hyparrhenia hirta	*Schoenoplectus paludicola*	*Cyperus esculentis*	*Typha latifolia*
Themeda triandra	*Cyperus rupestris*	*Helichrysum krausii*	*Nymphaea capensis*
**Verbena bonariensis*	*Panicum maximum*	*Cyperus marginatus*	*Leersia hexandra*
Stapelia hirsuta	*Andropogon eucomus*	*Andropogon eucomus*	*Andropogon eucomus*
	**Verbena bonariensis*	*Eragrostis plana*	*Cyperus rupestris*
	Ammocharis coranica	*Imperata cylindrica*	*Schoenoplectus paludicola*
	Imperata cylindrica	*Schoenoplectus paludicola*	*Phragmites australis*
	Miscanthus junceus	*Eragrostis plana*	*Juncus rigidus*
	Zygophyllum simplex	*Juncus rigidus*	*Asclepias fruticosa*
	Setaria verticillata	*Salsola glabrescens*	

5.4 Vegetation Index Score

The information gathered during the assessment of the study area was used to determine the Vegetation Index Score (VIS) - see Appendix B for calculations. Due to variation between the different habitat units, all habitat units were assessed separately. The table below lists the results of each habitat unit.

Table 7: Scoring for the Vegetation Index Score

Vegetation Index Score	Assessment Class	Description
22 to 25	**A**	Unmodified, natural
18 to 22	**B**	Largely natural with few modifications.
14 to 18	**C**	Moderately modified
10 to 14	**D**	Largely modified
5 to 10	**E**	The extensive loss of natural habitat
<5	**F**	Modified completely

Table 8: Vegetation Index Score for each habitat unit assessed

Habitat unit	Score	Class	Motivation
Transformed	5	**E – Extensive loss of natural habitat**	Transformation has occurred within this habitat unit to the degree that the majority of species that occur within the habitat unit are alien and invader species, with large portions being used as cultivated lands. Therefore, this habitat unit is classified as having undergone an extensive loss of natural habitat.
Secondary Grassland	14	**C – Moderately modified**	The secondary grassland is classified as moderately modified, as varying degrees of transformation was observed. However, many indigenous grass species do still occur within this habitat unit, and therefore the secondary grassland is still considered to be in a fair ecological condition.
Wetland habitat	16	**C – Moderately modified**	Transformation of the wetland system includes the impacts associated with grazing of livestock such as trampling and bank erosion and alien floral encroachment. However the wetlands still provides important niche habitat for SCC and as such are considered to be in an overall fair condition.

5.5 Floral SCC Assessments

An assessment considering the presence of any plant species of concern, as well as suitable habitat to support any such species was undertaken. The complete PRECIS (Pretoria Computer Information Systems) floral RDL lists for the grid reference 2726DA, 2726DC, and 2726DD (Appendix A) was acquired from SANBI.

Table 9: IUCN RDL Categories – Version 2014.1 as supplied by SANBI.

Category	Definition
EX	Extinct
EW	Extinct in the Wild
RE	Regionally Extinct
CE PE	Critically Endangered, Possibly Extinct
CE	Critically Endangered
EN	Endangered
VU	Vulnerable
NT	Near threatened
*CR	Critically Rare
*R	Rare
*Declining	Declining
LC	Least Concern
DDD	Data Deficient - Insufficient Information
DDT	Data Deficient - Taxonomically Problematic

Categories marked with * are non-IUCN, national Red List categories for species not in danger of extinction, but considered of conservation concern. The IUCN equivalent of these categories is Least Concern (LC).

Threatened species are species that are facing a high risk of extinction. Any species classified in the IUCN categories Critically Endangered, Endangered or Vulnerable is a threatened species.

SCC are species that have a high conservation importance in terms of preserving South Africa's high floristic diversity and include not only threatened species, but also those

classified in the categories: Extinct in the Wild (EW), Regionally Extinct (RE), Near Threatened (NT), Critically Rare, Rare, Declining and Data Deficient - Insufficient Information (DDD).

The SANBI PRECIS database listed only a single species, namely XXX, under the threatened categories. This species is present within the 2726DC QDS, with no RDL species indicated to occur within the 2726DA and 2726DD QDSs. More information regarding this species can be obtained from Table 10 below

Table 10: PRECIS plant list for the QDS 2726DC (Raimondo et al., 2009; SANBI, www.sanbi.org).

Family	Species	Threat status	Growth form	Habitat
APOCYNACEAE	*Brachystelma dimorphum*	Rare	Perennial geophyte/ succulent	Distributed in Free State and North West Province. It occurs within a terrestrial grassland and savannah habitat, in alluvial pans.

Table 11: POC for floral species of concern. (Raimondo *et al*., 2009)

Species	Habitat description	POC (%)	Motivation
Brachystelma dimorphum	Distributed in Free State and North West Province. It occurs within a terrestrial grassland and savannah habitat, in alluvial pans	80%	The habitat conditions are suitable for the presence of *B dimorphum* on site. However severe overgrazing and other agricultural activities have transformed the majority of the seasonal depressions within the study area.

This species was not encountered during the field assessment; however, the probability of *B. dimorphum* being present within the study area is highly likely, as several large seasonal depressions (alluvial pans) were present. Furthermore, three provincially protected species were encountered within the Wetland Habitat Unit, namely *Ammocharis coranica, Stapelia hirsuta* and *Crinum bulbispermum*. These species are protected under the draft version of the FSNCB, 2007), and if any individuals of these two species are to be disturbed, permits must be obtained from the FSDEDTEA to do so.

Thus by conserving the larger pans and valley bottom wetland, habitat for floral SCC will be conserved. If any activities are to affect the wetlands, a rescue and relocation plan for the above-mentioned species must be designed and overseen by a suitably qualified specialist.

5.6 Alien and Invasive Floral Species

Alien invaders are plants that are of exotic origin and are invading previously pristine areas or ecological niches (Bromilow, 2001). Not all weeds are exotic in origin but, as these exotic plant species have very limited natural “check” mechanisms within the natural environment, they are often the most opportunistic and aggressively growing species within the ecosystem. Therefore, they are often the most dominant and noticeable within an area. Disturbances of the ground through trampling, excavations or landscaping often leads to the dominance of exotic pioneer species that rapidly dominate the area. Under natural conditions, these pioneer species are overtaken by sub-climax and climax species through natural veld succession. This process however takes many years to occur, with the natural vegetation never reaching the balanced, pristine species composition prior to the disturbance. There are many species of indigenous pioneer plants, but very few indigenous species can out-compete their more aggressively growing exotic counterparts.

Alien vegetation invasion causes degradation of the ecological integrity of an area, causing (Bromilow, 2001):

- A decline in species diversity;
- Local extinction of indigenous species;
- Ecological imbalance;
- Decreased productivity of grazing pastures and
- Increased agricultural input costs.

The table below indicates the alien and invader species identified during the site assessment along with their relevant categories according to the NEMBA Alien and Invasive Species Regulations (2014). Most of these species were encountered in the transformed and secondary grassland habitat units.

Table 12: Alien or invasive species within the study area.

Species	English name	Type or Origin	NEMBA Category**
Tagetes minuta	Tall khaki weed	South America	N/A
Acacia mearnsii	Black wattle	Australia	2
Eucalyptus camaldulensis	Red River Gum	Australia	1b
Morus alba	Mulberry	China	3
Populus x canescens	Grey Poplar	Europe and Asia	2
Bidens pilosa	Blackjack	South America	N/A
Conyza bonariensis	Hairy Horseweed	North America	N/A
Plantago lanceolata	Ribwort	Europe	N/A
Schinus molle	Pepper Tree	Central America	N/A
Solanum elaeagnifolium	Silverleaf Nightshade	North America	1b
Sonchus oleraceus	Sow-Thistle	Europe, Asia and North America	N/A
Taraxacum officinale	Common Dandelion	Eurasia	N/A
Verbena tenuisecta	Fine leaf verbena	South America	N/A
Verbena bonariensis	Purple top	South America	1b

**Categories according to NEMBA (Alien and Invasive Species Regulations, 2014)

Category 1a - Invasive species that require compulsory control.

Category 1b - Invasive species that require control by means of an invasive species management programme.

Category 2 - Commercially used plants that may be grown in demarcated areas, provided that there is a permit and that steps are taken to prevent their spread.

Category 3 - Ornamentally used plants that may no longer be planted.

From the table above it is clear that a moderate to high diversity of alien species occurs within the study area, especially within the transformed areas. Alien species located on the study area need to be removed on a regular basis as part of maintenance activities according to the CARA (Act No. 43 of 1983).

5.7 Medicinal Plant Species

Medicinal plant species are not necessarily indigenous species, with many of them regarded as alien invasive weeds. The medicinal species are all commonly occurring species and are not confined to the study area.

The table below presents a list of plant species with traditional medicinal value, plant parts traditionally used and their main applications, which were identified during the field assessment. All of the medicinal species identified are considered to be common and widespread species and were not confined to any specific habitat unit. Therefore, the proposed mining development is not likely to have a significant impact on medicinal flora species conservation.

Table 13: Traditional medicinal plants identified during the field assessment. Medicinal applications and application methods are also presented (van Wyk, Oudtshoorn, Gericke, 2009).

Species	Name	Plant parts used	Medicinal uses
Eucalyptus camaldulensis	Red river gum	Leaves	Leaves are rich in essential oil. The leaves and oil are useful as decongestant medicines to treat colds and "flu".
Tagetes minuta	Tall khaki bush	Leaves	Highly aromatic leaves have repellent properties of essential oils used by gardeners to keep plants disease free. Oil used in perfumery and as flavouring in foods, beverages and tobacco.
Helichrysum krausii	Everlasting	Leaves, twigs and sometimes the roots	Many ailments are treated, including coughs, colds, fever, infections, headache and menstrual pains. It is a popular ingredient in wound dressing.
Vernonia oligocephala	Bitterbossie	Leaves and twigs	Abdominal pain and colic. Rheumatism, dysentery, and diabetes.
Asclepias fruticosa	Milkweed	Mainly leaves, sometimes roots.	Snuff is prepared from ground leaves and used for treatment of headaches, tuberculosis and a general emetic to strengthen body.
Plantago lanceolata	Ribwort plantain	Leaves	Anti-inflammatory and expectorant. Used to treat wounds, inflammation of skin and against catarrhs of the respiratory tract and inflammation of mouth and throat.
Conyza canadensis	Horseweed fleabane	Herb	Astringent, diarrhoea, diuretic, colds, insect repellent

6 SENSITIVITY MAPPING

The figure below conceptually illustrates the areas considered to be of increased ecological sensitivity in relation to the proposed mining project. Areas within the study area are depicted according to their sensitivity in terms of faunal and floral habitat integrity and their suitability to provide habitat to faunal and floral communities. The larger wetlands (Class C EIS) are considered to be sensitive, as they provide faunal and floral habitat in an area characterised by transformation due to agriculture and mining and also provide migratory corridors for faunal species. It is recommended that the proposed project complies with Regulation GN 704 of the National Water Act (Act no. 36 of 1998) which contains Regulations on use of water for mining and related activities aimed at the protection of water resources. GN 704 states that:

No person in control of a mine or activity may-

(a) locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100 year flood-line or within a horizontal distance of 100 metres from any watercourse or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become waterlogged, undermined, unstable or cracked;

According to the above, the project footprint must fall outside of the 1:100 year floodline of the wetlands or 100m from the edge of the feature, whichever distance is the greatest unless an exemption from GN 704 is obtained.

Construction activities occurring within 32m of the wetland features requires relevant authorisation according to the National Environmental Management Act (NEMA; Act No. 107 of 1998) and Section 21 c and i of the National Water Act (Act No 36 of 1998).

The secondary grassland habitat unit is considered to be of moderate sensitivity due to its ecological functionality and habitat integrity being moderate to low, and development within this habitat unit is supported. However, edge effects from any activities occurring in this habitat unit must be effectively mitigated in order to prevent adverse impacts on the surrounding wetland habitat unit.

The sensitivity of the transformed habitat unit is low. The diversity of alien plant species and severe vegetation transformation result in this habitat unit having a low ecological sensitivity and little conservation value from a floral biodiversity perspective. However, edge effects from any activities occurring in this habitat unit must be effectively mitigated in order to prevent negative impacts on the wetland habitat unit.

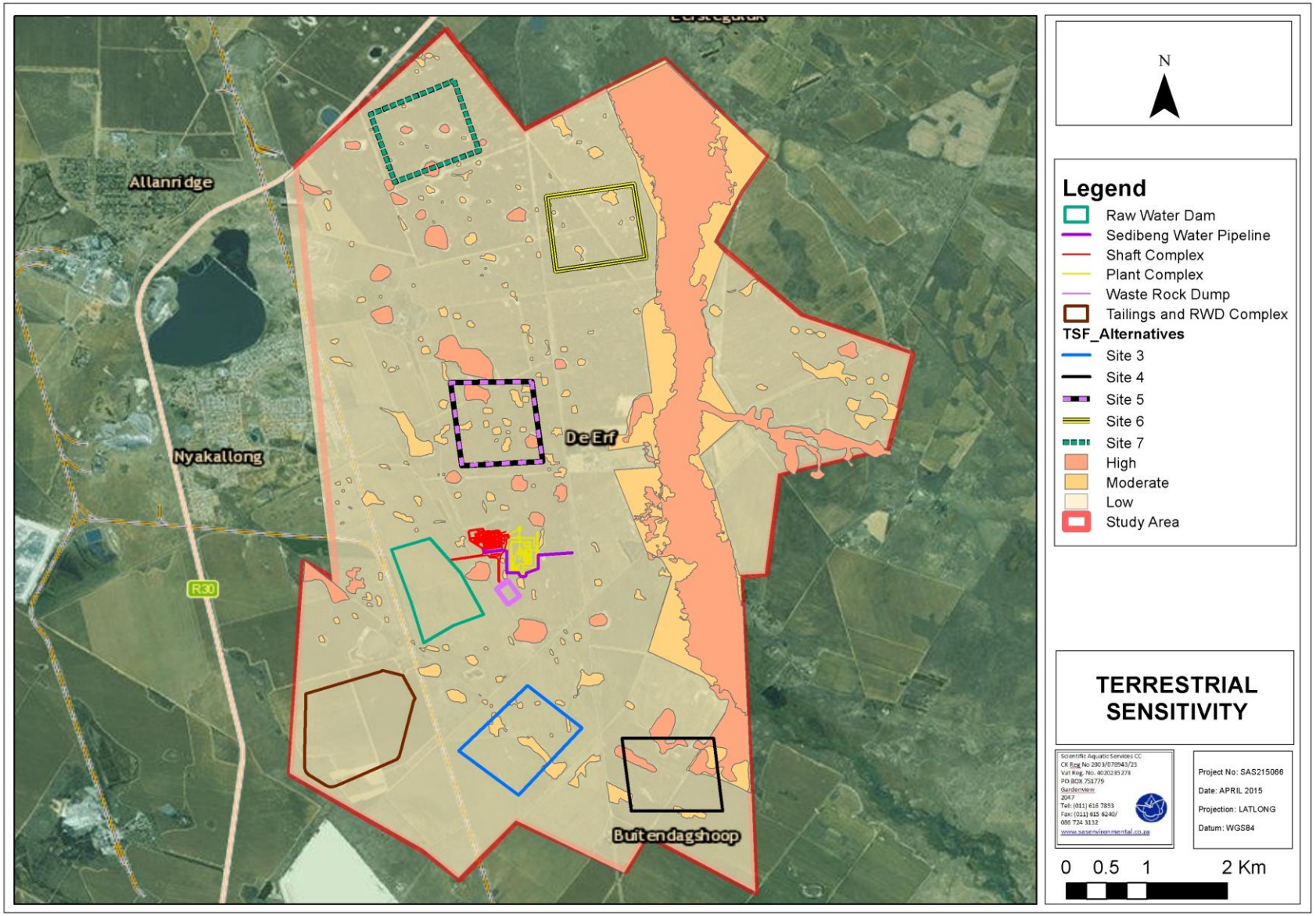

Figure 8: Sensitivity Map for the study area.

7 IMPACT ASSESSMENT

The tables below serve to summarise the significance of potential impacts on floral species and habitat that may result due to the proposed mining activities. A summary of all potential pre-construction, construction, operational and decommissioning and closure phase impacts is provided after the impact discussion. The sections below present the impact assessment according to the method described in Section A.

In addition, it also indicates the required mitigatory and management measures needed to minimise potential ecological impacts and presents an assessment of the significance of the impacts taking into consideration the available mitigatory measures, assuming that they are fully implemented.

- No fires whatsoever should be allowed on the proposed mining site.
- Appropriate sanitary facilities must be provided for the life of the mine and all waste removed to an appropriate waste facility.
- All soils compacted as a result of construction activities falling outside of the mining footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take place throughout all development and decommissioning phases to prevent loss of floral habitat.
- To prevent the erosion of top soils, management measures may include berms, soil traps, hessian curtains and storm water diversion away from areas susceptible to erosion. It must be ensured that topsoil stockpiles are located outside of any drainage lines and areas susceptible to erosion. Stockpiles should be placed away from areas known to contain hazardous substances such as fuel and if any soils are contaminated, it should be stripped and disposed of at a registered hazardous waste dumping site.
- All areas of disturbed and compacted soils need to be ripped and reprofiled.
- No dumping of waste should take place. If any spills occur, they should be immediately cleaned up.
- In the event of a breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced to prevent the ingress of hydrocarbons into the topsoil.
- It must be ensured that all roads and construction areas are regularly sprayed with water in order to curb dust generation. This is particularly necessary during the dry season when increased levels of dust generation can be expected. These areas

should not be over-sprayed causing water run-off and subsequent sediment loss in the vicinity of the study area.

- Ensure that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage. Regularly inspect all vehicles for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil.

7.1 Impact 1: Impact on Habitat for Floral Species

Activities and aspect registry

Pre-Construction	Construction	Operational	Decommissioning & Closure
Poor planning of infrastructure placement and design	Site clearing and the removal of vegetation	On-going disturbance of soils due to general operational activities leading to altered floral habitat	Ineffective rehabilitation of exposed and impacted areas and failure to implement a comprehensive alien floral control plan
Inadequate design of infrastructure	Loss of floral biodiversity through invasion of alien species	Increased introduction and proliferation of alien plant species and further transformation of natural habitat	Disturbance of soils as part of demolition activities
	Erosion as a result of infrastructure development and storm water runoff	Risk of discharge and contamination from all operational facilities may pollute receiving environment with special mention of the salinisation of soils	On-going seepage and runoff may affect the groundwater regime beyond closure
	Movement of construction vehicles and access road construction	Seepage affecting soils and the groundwater regime with special mention of the salinisation of soils	On-going risk of discharge from mining facilities beyond closure
	Dumping of material outside designated areas leading to loss of floral habitat	Runoff and seepage from operation facilities may lead to habitat loss with special mention of the salinisation of soils	Potential contamination from decommissioning of the plant and other mining facilities
	Compaction of soils reducing floral re-establishment	On-going disturbance may lead to erosion and sedimentation	Ineffective monitoring of rehabilitation due to poor management

Placement of infrastructure within the wetland habitat, especially the larger wetlands such as the valley bottom wetland, will result in permanent removal of vegetation considered to be of increased ecological importance and sensitivity. Although the vegetation within this habitat unit has been disturbed as a result of surrounding agricultural activities and grazing of livestock, these areas still provide habitat to support floral SCC such as *Stapelia hirsuta*, which was found within this habitat unit

The transformed and secondary grassland habitat units have been significantly disturbed as a result of historic and on-going agricultural activities and overgrazing of veld. The floral habitat within these habitat units is therefore largely transformed and placement of mining infrastructure within these habitat units will most likely have a low impact significance.

As the proposed mining will be mostly underground with limited surface infrastructure situated away from especially the valley bottom wetland, any significant surface impacts are

unlikely, and with implementation of mitigation measures the impact significance may be reduced to low levels.

Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	3	3	3	4	5	10	50 (Low)
Operational phase	2	3	3	3	4	5	10	50 (Low)
Decommissioning and closure phase	2	3	3	3	5	5	11	55 (Medium Low)

Essential construction phase mitigation measures:

- Keep the proposed mining infrastructure within designated low sensitivity areas as far as possible.
- Ensure that the proposed development footprint areas remain as small as possible
- If possible, avoid placement of infrastructure in the intact wetland areas.
- Restrict vehicles to travelling only on designated roadways to limit the ecological footprint of the proposed development activities.
- All soils compacted as a result of construction activities falling outside of the mining footprint areas should be ripped and profiled.

Recommended construction phase mitigation measures:

- During the construction phases erosion berms should be installed to prevent gully formation and siltation of the wetland resources in close proximity to infrastructure. The following points should serve to guide the placement of erosion berms:
  - Where the track has a slope of less than 2%, berms every 50m should be installed;
  - Where the track slopes between 2% and 10%, berms every 25m should be installed;
  - Where the track slopes between 10%-15%, berms every 20m should be installed; and
  - Where the track has a slope greater than 15%, berms every 10m should be installed.

Essential operation phase mitigation measures:

- Ensure that operational related activities are kept strictly within the development footprint.
- Alien and invasive vegetation control should take place throughout the operational phase of the development.
- In the event of a breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced to prevent the ingress of hydrocarbons into the topsoil.
- Restrict vehicles to travelling only on designated roadways to limit the ecological footprint of the proposed development activities.

Essential decommissioning and closure phase mitigation measures:

- All development footprint areas and areas affected by mine closure and decommissioning should remain as small as possible and should not encroach onto surrounding more sensitive wetland areas and the associated buffer zones. It must be ensured that these areas are off-limits to construction vehicles and personnel.
- Proliferation of alien and invasive species is expected within any disturbed areas. These species should be eradicated and controlled to prevent their spread beyond the development / decommissioning footprint. Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on future rehabilitation, has to be controlled.
- Upon closure and decommissioning of mining facilities, reseeding with indigenous grasses should be implemented in all affected areas.

Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	1	3	2	2	3	4	7	28 (Low)
Operational phase	1	3	2	3	3	4	8	32 (Low)
Decommissioning and closure phase	1	3	2	2	3	4	7	28 (Low)

Probable latent impacts

- Loss of floral habitat may lead to altered floral biodiversity.
- Ineffective rehabilitation may lead to permanent transformation of floral habitat and species composition.

7.2 Impact 2: Impact on Floral Diversity

Activities and aspects registry

Pre-Construction	Construction	Operational	Decommissioning & Closure
Poor planning of infrastructure placement and design	Site clearance and removal of vegetation	An increase in alien plant species leading to altered plant community structure and composition	Ineffective rehabilitation of exposed and impacted areas and failure to implement a comprehensive alien floral control plan
	Construction of infrastructure and access roads through natural areas leading to a loss of plant species diversity	Erosion and sedimentation as a result of operational activities leading to a loss of floral species diversity	Erosion and sedimentation as a result of closure and decommissioning activities leading to a loss of species diversity
	Increased fire frequency and intensity, as well as uncontrolled fires due to increased human activity may impact on plant communities	On-going edge effects from mining operations impacting on plant species diversity	Failure to monitor rehabilitation efforts and implement the alien floral control plan
	Increased anthropogenic activity and an increase in the collection of medicinal floral species	Increased vehicular and pedestrian movement may lead to loss of floral species	
		Increased fire frequency and intensity, as well as uncontrolled fires during mining operations due to increased human activity impacting on floral communities	

Floral diversity within all habitat units has been decreased as a result of historic and on-going disturbances. The species diversity is however higher within the wetland habitat unit than that associated with the secondary grassland and transformed habitat units. The impact significance associated with the loss of species diversity is considered to be low to medium low prior to the implementation of mitigation measures.

As the proposed mining will be mostly underground with limited surface infrastructure, any significant surface impacts are unlikely, and with implementation of mitigation measures, the impact significance may be reduced to low and very low levels.

Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	3	3	3	4	5	10	50 (Low)
Operational phase	2	3	3	3	4	5	10	50 (Low)
Decommissioning and closure phase	2	3	3	3	5	5	11	55 (Medium-Low)

Essential construction mitigation measures:

- Keep the proposed mining infrastructure within designated low sensitivity areas as far as possible.
- Planning of temporary roads and access routes should take the site sensitivity plan into consideration. If possible, such roads should be constructed a distance from the more sensitive wetland areas and not directly adjacent thereto.
- Prohibit the collection of plant material for firewood or for medicinal purposes.
- Species specific and area specific eradication recommendations:
  - Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used;
  - Footprint areas should be kept as small as possible when removing alien plant species; and
  - No vehicles should be allowed to drive through designated sensitive seasonal pans and valley bottom wetland areas during the eradication of alien and weed species.

Essential operation mitigation measures:

- An alien vegetation control plan has to be implemented in order to manage alien plant species occurring within the study area.
- Removal of the alien and weed species encountered within the mining footprint area must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and NEMBA (Alien and Invasive Species Regulations (2014). Removal of species should take place throughout the operational phase.
- Restrict vehicles to travelling only on designated roadways to limit the ecological footprint of the proposed development activities.
- To prevent the erosion of top soils, management measures may include berms, soil traps, hessian curtains and storm water diversion away from areas susceptible to erosion. It must be ensured that topsoil stockpiles are located outside of any drainage lines and areas susceptible to erosion. Stockpiles should be placed away from areas known to contain hazardous substances such as fuel and if any soils are contaminated, it should be stripped and disposed of at a registered hazardous waste dumping site.

Recommended operational mitigation measures:

- Prohibit the collection of plant material for firewood or for medicinal purposes.

Essential decommissioning and closure phase mitigation measures:

- All development footprint areas and areas affected by mine closure and decommissioning should remain as small as possible and should not encroach onto surrounding more sensitive wetland areas and the associated buffer zones. It must be ensured that these areas are off-limits to construction vehicles and personnel.
- An ongoing alien vegetation control plan has to be implemented in order to manage alien plant species occurring within the study area.
- Removal of the alien and weed species encountered within the mining footprint area must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and NEMBA (Alien and Invasive Species Regulations (2014). Removal of species should take place throughout the decommissioning/closure phase.
- All areas of disturbed and compacted soils need to be ripped and reprofiled.
- All areas affected by construction should be rehabilitated upon closure of the mining. Areas should be reseeded with indigenous grasses as required. All rehabilitated areas should be rehabilitated to a point where natural processes will allow the pre-development ecological functioning and biodiversity of the area to be re-instated.

Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	1	3	2	2	2	4	6	24 (Very Low)
Operational phase	1	3	2	2	3	4	7	28 (Low)
Decommissioning and closure phase	1	3	2	2	3	4	7	28 (Low)

Probable latent impacts

- Permanent loss of floral diversity within areas where construction has taken place.
- Ineffective rehabilitation may lead to permanent loss of floral biodiversity.

7.3 Impact 3: Impact on Floral SCC

Activities and aspects registry

Pre-Construction	Construction	Operational	Decommissioning & Closure
Poor planning of infrastructure placement and design	Site clearance and removal of important/ indigenous vegetation within the rocky ridge and wetland habitat	An increase in alien plant species leading to loss of medicinal plant species by outcompeting these species	Ineffective rehabilitation of exposed and impacted areas and failure to implement a comprehensive alien floral control plan leading to on-going loss of medicinal plants
	Construction of infrastructure and access roads through natural areas	Collection of medicinal floral species	
	Increased anthropogenic activity and an increase in the collection of plant material for medicinal purposes	Increased anthropogenic activity and an increase in the collection of plant material for medicinal purposes	
	Increased fire frequency and intensity, as well as uncontrolled fires due to increased human activity may impact on plant communities	Increased fire frequency and intensity, as well as uncontrolled fires due to increased human activity may impact on plant communities	

The protected species *Ammocharis coranica, Stapelia hirsuta* and *Crinum bulbispermum* were encountered within the Wetland Habitat Unit and may be affected if any activities are to encroach upon the valley bottom wetland and larger pans. The impact associated with the loss of these species is considered to be of low to medium-low significance prior to the implementation of mitigation measures. However, as the proposed mining will be mostly underground and surface infrastructure will be relatively small in extent and situated away from larger wetlands, any significant surface impacts are unlikely, and with implementation of mitigation measures the impact significance may be reduced to low levels.

Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	3	3	3	4	5	10	50 (Low)
Operational phase	2	3	3	3	4	5	10	50 (Low)
Decommissioning and closure phase	2	3	3	3	5	5	11	55 (Medium-Low)

Essential construction mitigation measures:

- The footprint of the proposed mining activities to occur on surface should be confined to areas presently/historically utilised for crop production as occurring within the Transformed Habitat Units and which are of low ecological importance.
- If possible, avoid placement of infrastructure in the seasonal pans and valley bottom wetland.
- Prohibit the collection of plant material for medicinal purposes.
- The existing integrity of flora surrounding the proposed mining site should be upheld and no activities be carried out outside the footprint of the construction areas.
- Edge effect control needs to be implemented to ensure no further degradation outside of the proposed footprint area.

Recommended construction mitigation measures:

- Should any other floral SCC be encountered within the study area in the future, the following should be ensured:
  - If any threatened species will be disturbed, ensure effective relocation of individuals to suitable areas; and
  - All rescue and relocation plans should be overseen by a suitably qualified specialist.

Essential operational phase mitigation measures:

- Ensure that operational related activities are kept strictly within the development footprint.
- Restrict vehicles to travelling only on designated roadways to limit the ecological footprint of the proposed development activities.
- Prohibit the collection of plant material for medicinal purposes.

Essential decommissioning and closure phase mitigation measures:

- All development footprint areas and areas affected by mine closure and decommissioning should remain as small as possible and should not encroach onto surrounding more sensitive wetland areas and the associated buffer zones. It must be ensured that these areas are off-limits to construction vehicles and personnel.
- Effective rehabilitation of disturbed areas during the life of the mine needs to take place by introducing indigenous species back into the environment.
- All areas of disturbed and compacted soils need to be ripped and re-profiled.
- All areas affected by construction should be rehabilitated upon closure of the mining. Areas should be reseeded with indigenous grasses as required. All rehabilitated areas should be rehabilitated to a point where natural processes will allow the pre-development ecological functioning and biodiversity of the area to be re-instated.
- An alien vegetation control plan has to be implemented in order to manage alien plant species occurring within the study area.

Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	1	3	2	2	3	4	7	28 (Low)
Operational phase	1	3	2	2	4	4	8	32 (Low)
Decommissioning and closure phase	1	3	2	2	3	4	7	28 (Low)

Probable latent impacts

- A decrease in medicinal floral species diversity may lead to a loss of species richness over time within the region.

7.4 Impact Assessment Conclusion

Based on the above assessment it is evident that there are three possible impacts which may affect the floral ecology within the study area. The tables below summarise the findings indicating the significance of the impacts before mitigation takes place as well as the significance of the impacts if appropriate management and mitigation takes place. Table 14 presents the summary for the construction phase of the project, Table 15 presents the summary for the operational phase impacts and Table 16 presents the summary for the decommissioning and closure phase.

Due to the bulk of the proposed mining activities being underground and surface infrastructure will be relatively small in extent and situated away from highly sensitive habitat, significant surface impacts are unlikely and the spatial scale is anticipated to be small and the project is supported from an ecological perspective. This lowers the impact significance throughput all phases. Should TSF alternative 2 be considered as the preferred alternative, this would further reduce the impact significance. However, mitigation measures must still be responsibly implemented in order to further minimise the anticipated impact.

Table 14: A summary of the impact significance of the construction phase.

Impact	Unmanaged	Managed
1: Impact on habitat for floral species	Low	Low
2: Impact on floral diversity	Low	Very-Low
3: Impact on important species	Low	Low

Table 15: A summary of the impact significance of the operational phase.

Impact	Unmanaged	Managed
1: Impact on habitat for floral species	Low	Low
2: Impact on floral diversity	Low	Low
3: Impact on important species	Low	Low

Table 16: A summary of the impact significance of the decommissioning and closure phase.

Impact	Unmanaged	Managed
1: Impact on habitat for floral species	Medium-Low	Low
2: Impact on floral diversity	Medium-Low	Low
3: Impact on important species	Medium-Low	Low

8 RECOMMENDATIONS

After the conclusion of this assessment, it is the opinion of the ecologists that the proposed mining activities be considered favourably, provided that the recommendations below are adhered to:

Development footprint

- A sensitivity map has been developed for the study area. It is recommended that this sensitivity map be considered during all development phases to aid in the conservation of floral habitat within the study area.
- It is recommended that TSF 2 be considered as the preferred alternative as no wetland areas will be affected.
- No activities are to infringe upon sensitive seasonal pans and the valley bottom wetland or associated buffer zones.
- Any proposed surface development footprint areas should remain as small as possible.
- All areas of increased ecological sensitivity should be designated as No-Go areas and be off limits to all unauthorised vehicles and personnel. Vehicles should be restricted to travelling only on designated roadways to limit the ecological footprint of the proposed development activities.
- It must be ensured that waste or spillage and effluent do not affect the sensitive habitat boundaries and associated buffer zones.

Alien floral species

- Removal of the alien and weed species encountered on the property must take place in order to comply with existing legislation (Conservation of Agricultural Resources Act, 1983 and NEMBA (Alien and Invasive Species Regulations 2014). Removal of alien and weed species should take place throughout the construction, operational, closure/decommissioning and rehabilitation/ maintenance phases.
- Species specific and area specific eradication recommendations:
  - Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used.
  - Footprint areas should be kept as small as possible when removing alien plant species.
  - No vehicles should be allowed to drive through designated sensitive wetland, buffer or intact grassland areas during the eradication of alien and weed species.

Soils

- It must be ensured that the pollution control system is managed in such a way as to prevent discharge to the receiving environment.

Rehabilitation

- All disturbed areas must be rehabilitated as soon as possible to ensure that floral ecology is re-instated to at least a self-sustaining, secondary state of ecological succession.
- Reseeding with indigenous grasses should be implemented in all affected areas and strategic planting of grassland species should take place to re-establish microclimates and niche habitats.

Fires

- Informal fires should be prohibited during all development phases.

Floral SCC

- Protected floral species such as *Stapelia hirsuta, Crinum bulbispermum* and *Ammocharis coranica* must be rescued and relocated with the process overseen by a botanist.
- If any of these are to be disturbed, permits must be obtained from the FSDEDTEA.
- Should any other floral SCC be encountered within the proposed development footprint areas, the following should be ensured:
  - If any threatened species, or nationally or provincially protected floral will be disturbed, ensure effective relocation of individuals to suitable similar habitat.
  - All rescue and relocation plans should be overseen by a suitably qualified specialist.

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APPENDIX A

Expected floral species list for QDS 2726DC, 2726DD and 2726DA

Table 17: Expected floral species list for the QDS 2726DC supplied by SANBI PRECIS Database.

Family	Species	Threat status	Lifecycle	Growth forms
AIZOACEAE	Trianthema parvifolia E.Mey. ex Sond. var. parvifolia	LC	Annual	Herb, succulent
AMARYLLIDACEAE	Nerine laticoma (Ker Gawl.) T.Durand & Schinz	LC	Perennial	Geophyte
APOCYNACEAE	Brachystelma dimorphum R.A.Dyer subsp. gratum R.A.Dyer	Rare	Perennial	Geophyte, succulent
ASPHODELACEAE	Bulbine abyssinica A.Rich.	LC	Perennial	Geophyte, herb, succulent
ASPHODELACEAE	Bulbine narcissifolia Salm-Dyck	LC	Perennial	Geophyte, herb, succulent
ASTERACEAE	Helichrysum paronychioides DC.	LC	Perennial	Dwarf shrub, herb
BRYACEAE	Bryum argenteum Hedw.		Perennial	Bryophyte
BRYACEAE	Bryum dichotomum Hedw.		Perennial	Bryophyte
CHENOPODIACEAE	Atriplex nummularia Lindl. subsp. nummularia	Not Evaluated	Perennial	Shrub
CHENOPODIACEAE	Bassia indica (Wight) A.J.Scott	Not Evaluated	Annual	Herb
CYPERACEAE	Bulbostylis hispidula (Vahl) R.W.Haines subsp. pyriformis (Lye) R.W.Haines	LC	Annual	Cyperoid, herb, mesophyte
CYPERACEAE	Cyperus difformis L.	LC	Annual	Cyperoid, helophyte, herb, mesophyte
CYPERACEAE	Cyperus eragrostis Lam.	Not Evaluated	Annual	Cyperoid, helophyte, herb
CYPERACEAE	Cyperus esculentus L. var. esculentus	LC	Perennial	Cyperoid, geophyte, herb, mesophyte
CYPERACEAE	Cyperus laevigatus L.	LC	Perennial	Cyperoid, helophyte, herb
CYPERACEAE	Cyperus longus L. var. tenuiflorus (Rottb.) Boeck.	LC	Perennial	Cyperoid, helophyte, herb
CYPERACEAE	Cyperus marginatus Thunb.	LC	Perennial	Cyperoid, helophyte, herb
CYPERACEAE	Cyperus usitatus Burch.	LC	Perennial	Cyperoid, geophyte, herb, mesophyte
CYPERACEAE	Kyllinga alata Nees	LC	Perennial	Cyperoid, helophyte, herb, mesophyte
CYPERACEAE	Schoenoplectus corymbosus (Roth ex Roem. & Schult.) J.Raynal	LC	Perennial	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	Schoenoplectus muricinux (C.B.Clarke) J.Raynal	LC	Perennial	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	Scirpoides dioeca (Kunth) Browning	LC	Perennial	Cyperoid, herb, mesophyte
FRANKENIACEAE	Frankenia pulverulenta L.	LC	Annual	Herb
IRIDACEAE	Babiana hypogaea Burch.	LC	Perennial	Geophyte, herb
JUNCACEAE	Juncus rigidus Desf.	LC	Perennial	Helophyte, herb
MOLLUGINACEAE	Hypertelis salsoloides (Burch.) Adamson var. salsoloides	LC	Perennial	Dwarf shrub
POACEAE	Anthephora pubescens Nees	LC	Perennial	Graminoid
POACEAE	Aristida adscensionis L.	LC	Annual	Graminoid
POACEAE	Brachiaria eruciformis (Sm.) Griseb.	LC	Annual	Graminoid

Family	Species	Threat status	Lifecycle	Growth forms
POACEAE	Bromus catharticus Vahl	Not Evaluated	Annual (occ. perennial)	Graminoid
POACEAE	Chloris virgata Sw.	LC	Annual (occ. perennial)	Graminoid
POACEAE	Cynodon dactylon (L.) Pers.	LC	Perennial	Graminoid
POACEAE	Cynodon transvaalensis Burtt Davy	LC	Perennial	Graminoid
POACEAE	Dactyloctenium aegyptium (L.) Willd.	LC	Annual	Graminoid
POACEAE	Echinochloa crus-galli (L.) P.Beauv.	LC	Annual	Graminoid
POACEAE	Echinochloa holubii (Stapf) Stapf	LC	Perennial	Graminoid
POACEAE	Eragrostis barrelieri Daveau	Not Evaluated	Annual	Graminoid
POACEAE	Eragrostis biflora Hack. ex Schinz	LC	Annual	Graminoid
POACEAE	Eragrostis curvula (Schrad.) Nees	LC	Perennial	Graminoid
POACEAE	Eragrostis lehmanniana Nees var. lehmanniana	LC	Perennial	Graminoid
POACEAE	Eragrostis mexicana (Hornem.) Link subsp. virescens (J.Presl.) S.D.Koch & Sánchez Vega	Not Evaluated	Annual	Graminoid
POACEAE	Eragrostis micrantha Hack.	LC	Perennial	Graminoid
POACEAE	Eragrostis obtusa Munro ex Ficalho & Hiern	LC	Perennial	Graminoid
POACEAE	Eragrostis superba Peyr.	LC	Perennial	Graminoid
POACEAE	Eragrostis trichophora Coss. & Durieu	LC	Perennial	Graminoid
POACEAE	Leptochloa fusca (L.) Kunth	LC	Perennial	Graminoid
POACEAE	Panicum coloratum L. var. coloratum	LC	Perennial	Graminoid
POACEAE	Panicum schinzii Hack.	LC	Annual	Graminoid
POACEAE	Paspalum dilatatum Poir.	Not Evaluated	Perennial	Graminoid
POACEAE	Paspalum distichum L.	LC	Perennial	Graminoid
POACEAE	Sporobolus fimbriatus (Trin.) Nees	LC	Perennial	Graminoid
POACEAE	Sporobolus ioclados (Trin.) Nees	LC	Perennial	Graminoid
POACEAE	Tarigidia aequiglumis (Gooss.) Stent	LC	Perennial	Graminoid
POACEAE	Themeda triandra Forssk.	LC	Perennial	Graminoid
POACEAE	Tragus berteronianus Schult.	LC	Annual	Graminoid
POACEAE	Tragus racemosus (L.) All.	LC	Annual	Graminoid
POACEAE	Urochloa panicoides P.Beauv.		Annual	Graminoid
POTAMOGETONACEAE	Potamogeton pectinatus L.	LC	Perennial	Herb, hydrophyte
RICCIACEAE	Riccia albolimbata S.W.Arnell		Perennial	Bryophyte
RICCIACEAE	Riccia albovestita O.H.Volk		Perennial	Bryophyte
SOLANACEAE	Lycium cinereum Thunb.	LC	Perennial	Dwarf shrub, shrub

Table 18: Expected floral species list for the QDS 2726DD supplied by SANBI PRECIS Database.

Family	Species	Threat status	Lifecycle	Growth forms
ASPHODELACEAE	Trachyandra asperata Kunth var. asperata	LC	Perennial	Geophyte, succulent
CHENOPODIACEAE	Atriplex semibaccata R.Br. var. typica Aellen	Not Evaluated	Annual (occ. perennial)	Dwarf shrub
POACEAE	Aristida diffusa Trin. subsp. burkei (Stapf) Melderis	LC	Perennial	Graminoid
POACEAE	Aristida junciformis Trin. & Rupr. subsp. junciformis	LC	Perennial	Graminoid
POACEAE	Eragrostis curvula (Schrad.) Nees	LC	Perennial	Graminoid
POACEAE	Eragrostis lappula Nees	LC	Perennial	Graminoid
XYRIDACEAE	Xyris gerrardii N.E.Br.	LC	Perennial	Helophyte, herb, hydrophyte

Table 19: Expected floral species list for the QDS 2726DA supplied by SANBI PRECIS Database.

Family	Species	Threat status	Lifecycle	Growth forms
APOCYNACEAE	Asclepias meyeriana (Schltr.) Schltr.	LC	Perennial	Herb
CHENOPODIACEAE	Atriplex suberecta I.Verd.	LC	Annual	Herb
CHENOPODIACEAE	Salsola rabieana I.Verd.	LC	Perennial	Dwarf shrub, shrub
CYPERACEAE	Bolboschoenus glaucus (Lam.) S.G.Sm.	LC	Perennial	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	Bulbostylis hispidula (Vahl) R.W.Haines subsp. pyriformis (Lye) R.W.Haines	LC	Annual	Cyperoid, herb, mesophyte
CYPERACEAE	Cyperus margaritaceus Vahl var. margaritaceus	LC	Perennial	Cyperoid, herb, mesophyte
CYPERACEAE	Schoenoplectus muricinux (C.B.Clarke) J.Raynal	LC	Perennial	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	Schoenoplectus pulchellus (Kunth) J.Raynal	LC	Perennial	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	Schoenoplectus senegalensis (Hochst. ex Steud.) Palla	LC	Annual	Cyperoid, emergent hydrophyte, helophyte, herb
FABACEAE	Indigofera daleoides Benth. ex Harv. var. daleoides	LC	Perennial	Herb
FABACEAE	Sesbania notialis J.B.Gillett	LC	Annual	Herb
POACEAE	Eragrostis curvula (Schrad.) Nees	LC	Perennial	Graminoid
POACEAE	Sporobolus albicans (Nees ex Trin.) Nees	LC	Perennial	Graminoid
POACEAE	Sporobolus oxyphyllus L.Fish	LC	[No lifecycle defined]	Graminoid
SOLANACEAE	Lycium hirsutum Dunal	LC	Perennial	Dwarf shrub, shrub
SOLANACEAE	Nicotiana longiflora Cav.	Not Evaluated	Annual	Herb

APPENDIX B

Vegetation Index Score

Vegetation Index Score – Secondary Grassland Habitat Unit

1. *EVC=[[(EVC1+EVC2)/2]*

EVC 1 - Percentage natural vegetation cover:

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Site score					X	
EVC 1 score	0	1	2	3	4	5

EVC2 - Total site disturbance score:

Disturbance score	0	Very Low	Low	Moderately	High	Very High
Site score			X			
EVC 2 score	5	4	3	2	1	0

2. *SI=(SI1+SI2+SI3+SI4)/4)*

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
Score:	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State
Continuous							X	
Clumped		X		X	X	X		X
Scattered			X					
Sparse	X							

Present State (P/S) = Currently applicable for each habitat unit

Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived Reference state (PRS)	**Continuous**	**Clumped**	**Scattered**	**Sparse**
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. PVC=[(EVC)-((exotic x 0.7) + (bare ground x 0.3))

Percentage vegetation cover (exotic):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %			X			
PVC Score	0	1	2	3	4	5

Percentage vegetation cover (bare ground):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %					X	
PVC Score	0	1	2	3	4	5

4. RIS

Extent of indigenous species recruitment	0	Very Low	Low	Moderate	High	Very High
					X	
RIS	**0**	**1**	**2**	**3**	**4**	**5**

VIS = [(EVC)+((SIxPVC)+(RIS))] = 14

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score	Assessment Class	Description
22 to 25	**A**	Unmodified, natural
18 to 22	**B**	Largely natural with few modifications.
14 to 18	**C**	Moderately modified
10 to 14	**D**	Largely modified
5 to 10	**E**	The loss of natural habitat extensive
<5	**F**	Modified completely

Vegetation Index Score –Transformed Habitat Unit

1. EVC=[(EVC1+EVC2)/2]

EVC 1 - Percentage natural vegetation cover:

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Site score		X				
EVC 1 score	0	1	2	3	4	5

EVC2 - Total site disturbance score:

Disturbance score	0	Very Low	Low	Moderately	High	Very High
Site score					X	
EVC 2 score	5	4	3	2	1	0

2. SI=(SI1+SI2+SI3+SI4)/4)

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
Score:	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State
Continuous								
Clumped					X	X	X	X
Scattered		X		X				
Sparse	X		X					

Present State (P/S) = Currently applicable for each habitat unit

Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived Reference state (PRS)	**Continuous**	**Clumped**	**Scattered**	**Sparse**
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. PVC=[(EVC)-(exotic x 0.7) + (bare ground x 0.3)]

Percentage vegetation cover (exotic):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %				X		
PVC Score	0	1	2	3	4	5

Percentage vegetation cover (bare ground):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %					X	
PVC Score	0	1	2	3	4	5

4. RIS

Extent of indigenous species recruitment	0	Very Low	Low	Moderate	High	Very High
					X	
RIS	**0**	**1**	**2**	**3**	**4**	**5**

VIS = [(EVC) + (SI x PVC)+(RIS)] = 5

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score	Assessment Class	Description
22 to 25	**A**	Unmodified, natural
18 to 22	**B**	Largely natural with few modifications.
14 to 18	**C**	Moderately modified
10 to 14	**D**	Largely modified
5 to 10	**E**	The loss of natural habitat extensive
<5	**F**	Modified completely

Vegetation Index Score –Wetland Habitat Unit

1. EVC=[(EVC1+EVC2)/2]

EVC 1 - Percentage natural vegetation cover:

Vegetation cover %	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Site score					X	
EVC 1 score	0	1	2	3	4	5

EVC2 - Total site disturbance score:

Disturbance score	0	Very Low	Low	Moderately	High	Very High
Site score				X		
EVC 2 score	5	4	3	2	1	0

2. SI=(SI1+SI2+SI3+SI4)/4)

	Trees (SI1)		Shrubs (SI2)		Forbs (SI3)		Grasses (SI4)	
Score:	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State	Present State	Perceived Reference State
Continuous								
Clumped					X	X	X	X
Scattered		X	X	X				
Sparse	X							

Present State (P/S) = Currently applicable for each habitat unit

Perceived Reference State (PRS) = If in pristine condition

Each SI score is determined with reference to the following scoring table of vegetation distribution for present state versus perceived reference state.

	Present state (P/S)			
Perceived Reference state (PRS)	**Continuous**	**Clumped**	**Scattered**	**Sparse**
Continuous	3	2	1	0
Clumped	2	3	2	1
Scattered	1	2	3	2
Sparse	0	1	2	3

3. PVC=[(EVC)-(exotic x 0.7) + (bare ground x 0.3)]

Percentage vegetation cover (exotic):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %		X				
PVC Score	0	1	2	3	4	5

Percentage vegetation cover (bare ground):

	0%	1-5%	6-25%	26-50%	51-75%	76-100%
Vegetation cover %				X		
PVC Score	0	1	2	3	4	5

4. RIS

Extent of indigenous species recruitment	0	Very Low	Low	Moderate	High	Very High
					X	
RIS	**0**	**1**	**2**	**3**	**4**	**5**

VIS = [(EVC)+(SI x PVC)+(RIS)] = 16

The final VIS scores for each habitat unit are then categorised as follows:

Vegetation Index Score	Assessment Class	Description
22 to 25	**A**	Unmodified, natural
18 to 22	**B**	Largely natural with few modifications.
14 to 18	**C**	Moderately modified
10 to 14	**D**	Largely modified
5 to 10	**E**	The loss of natural habitat extensive
<5	**F**	Modified completely